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The application of digital radiography and radiodensitometry in evaluation of chronic fibrous periapical changes of endodontically untreated teeth

In dentistry resorption is defined as a complex of physiological and pathological factors causing the loss of hard tissues of teeth and alveolar bone (6). The resorptions of dental roots can be divided into physiological (in deciduous teeth) and pathological ones: internal and external. The ethiopathogenesis of internal resorptions is still unclear (7). On the other hand, there exist numerous causes of external resorptions and one of them is chronic periapical inflammation. The group of chronic periapical changes can be divided into fibrous, granulomatous and purulent ones. In chronic periapical processes it is the productive changes that predominate in the pathogenesis of such lesions. Thus both in the alveolar bone and in teeth tissues appear deposits of more mineralised structures as the result of productive changes. As a consequence of protective mechanisms in cases of fibrous periapical lesions there develop layers of bone trabeculae around endodontically untreated roots.

The aim of the radiological examinations is to determine the extent of pathological lesions. However, changes in hard tissues of teeth can be detected on a radiogram only when the change of mineralisation was significant in the form of hypermineralisation or demineralisation (9, 10).

Properly taken intraoral X-ray allows for the examination of hard tissues of teeth. By means of digital radiography it is possible to diagnose the pathological changes of teeth more precisely, at the same time eliminating a high dose of harmful ionising radiation that leads to decrease in diagnostic risk (4, 8, 11, 12). Nowadays a dentist will not start a treatment, especially endodontic one, without imaging diagnostics (11, 18, 19). However, it is becoming indispensable to elaborate the methodology of digital radiography for the use of a dental practice. That is why the aim of the paper is the radiodensitometric evaluation of natural defects in hard tissues of teeth and the determination of the degree of changes in mineralisation of roots due to their resorption in cases of chronic fibrous periapical lesions as well as the evaluation of the applicability and purpose of densitometric analysis in the diagnostics and treatment of such pathologies.

MATERIAL AND METHODS

On the basis of the collected material there was carried out the analysis of intraoral dental X-rays taken by means of digital radiography Digora Soredex Version 1.51 Rev. 2 and Dexa-CDR Schick systems. For the purpose of the study there were chosen the X-rays of patients in whom the resorption of dental roots caused by inflammatory changes was found. The whole analysed material consisted of 308 intraoral radiograms of teeth with clinically determined chronic periapical changes. As it was required to analyse the entire material in the same, one system, digital radiograms from the Dexa-CDR system were transferred to the Digora system owing to the compatibility of software. Afterwards the radiograms underwent standard analysis in the Digora system. All intraoral dental X-rays were taken using the bisected angle technique with the intraoral dental radiographs: Prostyle Intra X-ray Unit (Planmeca) and Heliodent MD 8458 747x1744 (Siemens) suitable for cooperation with digital radiography systems.

The examination of the gathered material started with the evaluation of radiograms in grey scale, followed by the full colour option. By means of the so-called tomosynthesis option an attempt was made to determine as precisely as possible the extent of the pathological changes (3, 11). Next the changes in mineralisation of roots were evaluated using the radiodensitometric function depending on the periapical inflammation. The measurements of pathologically changed roots were carried out at the distance of 1 mm from the radiological apex along a line (Fig. 1).

Fig. 1. An example of density measurements of root in case of chronic fibrous periapical inflammation

There were noted the minimum, maximum and mean values of densities along the line of measurement (Fig. 2).

Fig. 2. An example of density measurements of alveolar bone in case of chronic fibrous periapical inflammation

Then the density of alveolar bone was measured along a line at the distance of 2 mm from tooth apex (Fig. 3).

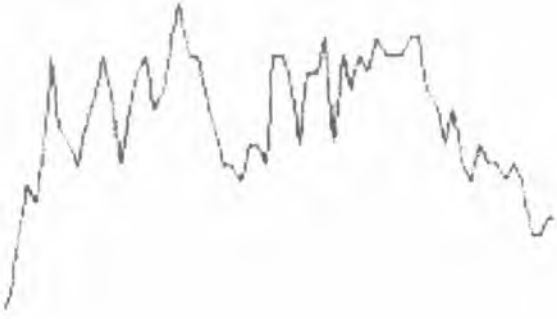

Fig. 3. Results of radiodensitometric measurements of root with chronic fibrous periapical changes

There were also radiodensitometrically determined densities of roots and alveolar bone of 25 teeth with no evident dental pathologies as these teeth formed the control group.

RESULTS

Mean value of density measured by means of radiodensitometry in the alveolar bone in the vicinity of root of untreated endodontically tooth equalled 124.39, while the minimum was 113.29 and the maximum 136.42. As far as the measurements of the density of root are concerned, the mean value was equal 136.19 while the extremes reached from the minimum of 131.29 to the maximum of 147.63. The results of measurements suggest that the density of the root itself in radiodensitometric evaluation is higher than in cases of acute changes, at the same time being decreased in comparison with sound teeth with no evident pathologies.

The results of the measurements are presented in Table 1 and in Figure 4:

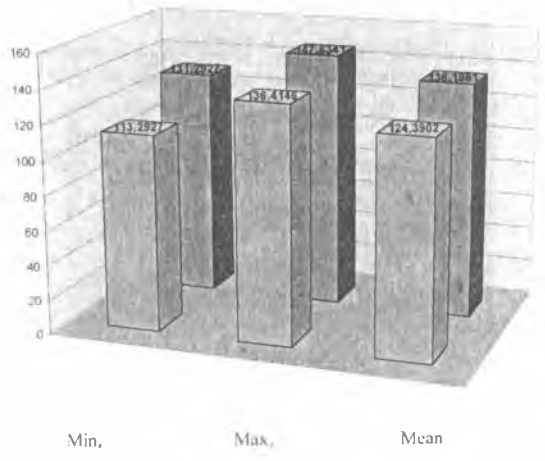

Fig. 4. Average values of minimum, maximum and mean results of density measurements in cases of chronic fibrous periapical changes

DISCUSSION

Modern methods of dental treatment require precise radiological diagnostics (11). On a conventional radiogram it is possible to detect the lesions only when the demineralisation of tooth and the surrounding bone was extensive enough to produce a defect (a lucency) on the image (11). One of the most up to date diagnostic utensils of dentists is the digital radiography (1, 11, 15, 16). Among its many advantages there can be underlined the minimalisation of ionising radiation necessary for exposure, stable good quality of radiograms as well as the possibility of storing the data and the digital elaboration of radiograms (11, 13, 15, 16, 20). Due to many options of software the diagnostic possibilities of dentists are increased. From now on they can use not only their own perception and subjective evaluation of image depending on many internal and external conditions, but they can use the image processing tools, as well.

Table 1. The results of radiodensitometric measurements of roots and alveolar bone in cases of chronic fibrous periapical changes of endodontically untreated teeth

Chronic fibrous periapical changes of endodontically untreated teeth					
Roots			Alveolar bone		
Min	Max	Mean	Min	Max	Mean
103	114	110	83	96	87
107	129	121	105	127	115
106	140	130	105	126	114
123	137	131	74	108	91
93	111	103	57	100	85
112	129	122	109	132	121
154	164	159	149	160	154
152	162	157	154	163	158
154	167	160	143	159	151
130	159	143	100	125	110
141	174	156	111	131	120
149	161	155	115	135	124
160	168	164	111	136	123
142	159	15	113	136	126
150	162	156	122	146	133
150	170	162	116	131	124
151	159	154	119	147	129
145	160	154	116	136	125
144	161	153	116	147	126
158	168	162	110	151	131
146	159	152	119	134	125
150	159	154	118	145	129
145	154	150	120	136	126
159	169	164	158	169	162
145	160	152	152	169	159
155	170	163	147	172	161
157	169	162	153	164	159
129	142	134	123	142	133
115	132	123	124	144	137
124	137	131	124	139	133
117	140	128	96	118	107
131	140	135	126	143	134
99	121	108	58	120	85
104	127	113	109	134	125
84	118	96	49	95	69
98	127	113	80	124	99
105	122	114	77	113	96
117	130	123	109	133	124
110	122	115	99	121	109
114	129	123	123	131	127
112	130	123	105	122	115

Radiological diagnostics of dental pathologies, mainly caries and periapical inflammations, has many shortages. Digital radiography using radiodensitometric measurements is superior to conventional radiograms in the field of detection of changes such as initial carietic defects or early inflammatory changes that cause little or even no demineralisation of hard tissues in the first stages (2, 5).

Alterations in bone structure visible on radiograms in cases of chronic periapical inflammation result for the most part from the spreading of odontogenic inflammatory processes in the alveolar tissues in the area surrounding a pathologically changed tooth (15). The signs of such chronic

inflammations can be analysed by means of digital radiography tools. It was T h u n - S z r e t t e r et al. (15, 16), who performed digital radiography examination with the Digora system in patients with clinically confirmed chronic periapical inflammation just before resection of roots. In these patients these authors used the gray scale and contrast enhancement as well as performed density measurements along a chosen line and in a given area. It was concluded that the function of density measurements (i.e. gray scale level in a given point, ranging from 0 to 256) was more objective and more reliable than human evaluation. Moreover, linear density measurement as well as measurement in a given area, are an additional, easy tool, which can be useful in the diagnostics and assessment of treatment results in cases of chronic periapical changes. That is consistent with the results of the presented own research works as in the study there were carried out density measurements using the Digora digital radiography system in cases of chronic periapical inflammatory changes. However, the lesions were divided according to the pathomorphological classification into fibrous, granulomatous and purulent inflammations (6). For the purpose of the research the groups were further subdivided into changes accompanying endodontically treated and untreated teeth. The results were correlated with the values of density measurements of roots and alveolar bone of teeth located in vicinity that showed no evident pathology. There were obtained significantly lower results of radiodensitometric measurements in cases of chronic periapical changes in comparison with the control group of roots as well as alveolar tissues of healthy teeth. It should be underlined that the differences between the values of measured densities in cases of pathologically changed teeth and healthy ones were more significant in the group of measurements of alveolar bone densities than in these of roots. It may suggest that the alveolar bone is more affected by the chronic periapical inflammatory process than the roots themselves.

A feature differentiating chronic fibrous changes in radiodensitometric image is the result of density measurements of the root of an affected tooth, which is higher than in case of acute inflammatory changes (3), but still this value is lower than in the control group of healthy teeth. Furthermore, as a consequence of protective mechanisms in cases of fibrous chronic inflammatory changes at apices of endodontically untreated teeth there appear layers of bone trabeculae that cause the increase in measured values.

CONCLUSIONS

1. There was proved the usefulness of radiodensitometry in evaluation of chronic fibrous periapical changes.

2. There were found significantly lower values of density measurements of roots and alveolar bone in the group of chronic fibrous periapical lesions in comparison with the control group.

3. A characteristic feature of chronic fibrous periapical changes is the density of the root of an affected tooth that is higher than in acute inflammation and at the same time lower than in the control group.

4. As a consequence of protective mechanisms in cases of fibrous chronic inflammatory changes at apices of endodontically untreated teeth there appear layers of bone trabeculae that cause an increase in measured values.

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SUMMARY

Lesions in hard tissues of teeth can be detected on radiograms only when there exists considerable decrease in mineralisation. By means of digital radiography the diagnostics of dental pathologies becomes more precise and objective. The aim of the paper was the radiodensitometric evaluation of chronic fibrous periapical changes. The material comprised 308 digital intraoral radiograms of teeth with periapical changes among which there were chosen the cases of clinically confirmed chronic fibrous periapical inflammations of endodontically untreated teeth. All radiograms were analysed in the Digora Soredex digital radiography system in gray scale, in full colour and using the tomosynthesis function. The linear measurements of root densities were carried out at the distance of 1 mm from radiological apices while the measurements of alveolar bone at the distance of 2 mm from it. Twenty--five teeth without evident periapical changes formed the control group. There were found significantly lower densities of roots and alveolar bone in the group of chronic fibrous periapical lesions in comparison with the control group. A characteristic feature of chronic fibrous periapical changes is the density of the root of an affected tooth that is higher than in acute inflammation and at the same time lower than in the control group. The radiodensitometry proved to be useful in evaluation of chronic fibrous periapical changes.

Zastosowanie radiografii cyfrowej i radiodensytometrii do oceny przewlekłych włóknistych zmian przy wierzchołkach zębów nie leczonych endodontycznie

Zmiany patologiczne w tkankach twardych zęba można wykryć na zdjęciu rentgenowskim tam, gdzie nastąpiła duża zmiana mineralizacji tkanek. Wykorzystanie radiografii cyfrowej sprawia, że diagnostyka staje się bardziej precyzyjna i obiektywna. Celem pracy była radiodensytometryczna ocena przewlekłych włóknistych zmian okołowierzchołkowych przy niewypełnianych korzeniach. Materiał obejmował 308 cyfrowych zdjęć zębów ze zmianami okołowierzchołkowymi, spośród których wybrano zdjęcia pacjentów z rozpoznanymi klinicznie przewlekłymi włóknistymi zmianami zapalnymi. Zdjęcia analizowano w systemie radiografii cyfrowej Digora Soredex w odcieniach szarości, w pełnym kolorze oraz wykorzystując funkcję tomosyntezy. Pomiary gęstości korzeni przeprowadzano w odległości 1 mm od wierzchołka radiologicznego wzdłuż jednej linii, a następnie mierzono gęstość tkanki kostnej zębodołu w odległości 2 mm od wierzchołka korzenia. Określano także gęstość korzeni i tkanki zębodołu 25 zębów bez uchwytnych zmian patologicznych, które stanowiły grupę kontrolną. Stwierdzono istotnie niższe wyniki pomiarów gęstości korzeni i tkanki zębodołu w przypadkach przewlekłych zmian okołowierzchołkowych w porównaniu z grupą kontrolną. Cechą wyróżniającą przewlekłe zmiany włókniste w radiografii cyfrowej jest wynik pomiaru gęstości samego korzenia zmienionego zęba, która jest wyższa niż w przypadku ostrych zmian zapalnych, a jednocześnie obniżona w porównaniu z grupą kontrolną. Wykazano przydatność pomiarów radiodensytometrycznych do oceny przewlekłych włóknistych zmian przywierzchołkowych.